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Blended learning in elementary school science learning: A systematic literature review

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ABSTRACT

This article presents a systematic literature review (SLR) on blended learning in elementary school science learning. The method used is SLR and PRISMA protocol with the stages of identification, screening, eligibility, inclusion, abstraction, and data analysis assisted by Publish or Perish 7, Mendeley, VOSviewer, and NVIVO 12 Plus applications. The findings in Scopus found 906 articles, and then filtered them according to compatible themes into 54 pieces. The topic findings were blended learning, science learning, elementary school, the concept of blended learning, type of blended learning, the impact of blended learning, flipped learning, flip classroom, distance learning, distance education, active learning, online learning, blended and face-to-face learning, STEM, which were directly and indirectly connected. The 54 articles were analyzed according to the defined topics through NVIVO 12 Plus, and the results were described according to the research questions. The research findings explain that blended learning in elementary school science learning is a mixed learning model with the integration of synchronous-asynchronous technology, information, and communication technology (ICT), technological pedagogical content knowledge (TPACK), multimedia, and Android from planning to evaluation. The most studied type of blended learning is the flipped classroom, with as many as 11 studies. The implementation of blended learning has more positive impacts on students and teachers. Future research needs to explore blended learning in elementary school science learning and what students, teachers, and technological developments need.

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1. INTRODUCTION

Research in several countries examines blended learning in elementary schools applied to various subjects [1]–[5]. However, research on blended learning in elementary school science learning with the systematic literature review (SLR) method from 2018-2022 is still minimal [6], [7]. Research findings on the topic of blended learning with SLR, bibliometric, scooping review, and meta-analysis are dominant in the study of the flipped classroom model [8], challenges of blended learning [9], blended learning vs. traditional learning in nursing education [10], blended learning in programming [11], mobile learning [12], science, technology, engineering, and mathematics (STEM) learning [13], nursing students' learning [14], physiology [15], physiotherapy [16], entrepreneurship [17], high school physics [18], and English in primary school [19].

Blended learning has been implemented in almost all countries since the COVID-19 pandemic, although this learning model has been implemented in developed countries since the 1980s [20]–[23]. Since

the pandemic, blended learning has been chosen as a learning model in elementary schools. Consequently, teachers must be good at organizing and developing digital tools [24], [25]. Since the pandemic, blended learning has been chosen as a learning model in elementary schools, and consequently, teachers must be good at organizing and developing digital tools [26]–[28].

Blended learning in elementary school science learning impacts increasing motivation, understanding, achievement, academic orientation, computational thinking skills, teacher services to students and parents assisted by technology [29]–[31], improving 21st-century thinking skills in students [32], strengthening of concepts, knowledge, facts, and metacognition in science materials such as general science concepts, and water concepts [33], science process, science attitude, science product [34], and improved academic achievement of science materials in elementary school with a passing grade [35]. The negative impacts are internet connection disruption, waste, and student dissatisfaction with online learning [36], students are less active, less responsible [37], reduced motivation, student learning achievement [38], and teachers are drained of energy, time, and lack focus [39]. This requires teachers to master the concepts and techniques of applying blended learning based on information and communication technologies (ICT), multimedia, and games in elementary school science learning [40], [41].

Blended learning is real-time learning that combines face-to-face instruction with data-driven, teacher-led, and student-acted ICT utilization. The characteristics of blended learning are that students have control of content, time, pace, place of learning, utilizing technology, digital media, internet, with the form of classrooms that physically present students and teachers [42]–[44]. There are at least 12 types of blended learning: station rotation, lab rotation, flex, flipped classroom, remote and enriched virtual, self-directed, project-based, inside-out, outside-in, mastery-based, and supplemental [45], [46].

In elementary school science learning, the blended learning model is implemented with the integration of innovative pedagogy, initiative, internet utilization [47], multimedia, websites [48], inquiry [49], WhatsApp [50], and digital technologies [51]. In elementary school science learning, teachers choose a type of blended learning that is adjusted to the teacher's ability, ICT, multimedia, and students' condition [52]. The choice of blended learning type in elementary science learning impacts students' socio-emotional and teacher professionalism [53], learning effectiveness, learning independence, and safety behavior in elementary school students [54].

The advantages of blended learning include deep learning, varied learning resources, inclusive inquiry, cross-cycle learning, digital-based and reality-based projects [55], [56]. Teachers cannot stay in their comfort zone because they have to maximize teaching, develop multimedia, master the material, and need periodic training [57], [58]. Further systematic studies are required on blended learning in elementary school science learning, as teachers must understand the concepts, types, and impacts of blended learning [59]. In general, this background explores the description of blended learning in elementary school science learning that is reviewed and analyzed using the SLR method.

The results of this research are expected to provide an overview of blended learning in elementary school science learning. The researchers asked three research questions: i) What is the concept of blended learning in elementary school science learning?; ii) What are the types of blended learning widely applied in elementary school science learning?; and iii) What is the impact of blended learning in elementary school science learning?

2. RESEARCH METHOD

2.1. Research design

The SLR method is applied in this study by presenting a description, review, and analysis of the concept, type, and impact of blended learning in elementary school science learning [60]–[62]. To identify, screen, test eligibility, include data, analyze, and present in narrative form, this research applies the preferred reporting items for systematic reviews and meta-analyses (PRISMA) technique. The flow that is done is identification, screening, eligibility, and inclusion objectively according to the results of the data reviewed in current articles related to the specified topic [63]–[65].

2.2. Inclusion and exclusion criteria for selection of publications

There were six things done in this inclusion and exclusion stage, namely: i) Articles indexed in the Scopus database; ii) Articles searched based on the topic of blended learning in science learning elementary school; iii) The Publish or Perish 7 application was used as a medium for searching literature on the Scopus database by entering the API Key; iv) The literature studied was only scientific articles. Papers, conference proceedings, book chapters, dissertations, and these are not used; v) Articles are in English; and vi) The publication of articles is limited to 2018-2022.

2.3. Screening and eligibility assessment for data analysis

Screening of literature from Scopus was conducted on July 15, 2022, with the help of the Publish or Perish 7 application. Screening occurred on aspects of title, abstract, and keywords specific to the theme and not too general. The search findings obtained 906 articles from Scopus with details in Table 1.

Table 1. Findings of articles from Scopus databases through Publish or Perish 7

No.	Keyword	Quantity
1	Blended learning in elementary school	80 articles
2	Blended learning in elementary school science learning	13 articles
3	Blended learning	200 articles
4	Blended learning in science learning	200 articles
5	Science learning with blended learning	200 articles
6	Science learning with blended learning in elementary school	13 articles
7	Blended learning in science	200 articles
	Total	906 articles

Of the 906 articles found, the same articles were discarded, and 54 remained. Furthermore, the 54 selected papers were entered into Mendeley, saved in RIS format, then entered into the VOSviewer application version 1.6.17 to map the initial network of theme relevance. The steps for entering into VOSviewer are: i) opening the application and selecting the menu to create a map based on bibliographic data; ii) reading data from the reference manager file; iii) selecting a file from the folder; iv) choosing the type of analysis and counting method, namely type of analysis: co-occurrence, unit of analysis: keywords, and counting method: full counting; v) verify selected keywords. According to the initial thematic association analysis results, the theme of blended learning science learning elementary school shows a very complex association pattern in Figure 1 and a visualization of the distribution of articles based on keywords in VOSviewer in Figure 2.

Figure 1 and Figure 2 show that the study of blended learning in elementary school science learning is very close to several other study themes such as blended learning, science learning, elementary school, concept of blended learning, type of blended learning, impact of blended learning, flipped learning, flip classroom, distance learning, distance education, active learning, online learning, blended and face-to-face learning, asynchronous online learning, and STEM. Some keywords with a distant connection to the theme of the study are blended professional development, behavioral engagement, achievement, contextual design, collegiality, e-learning, adaptations, speech therapy, contextual design.

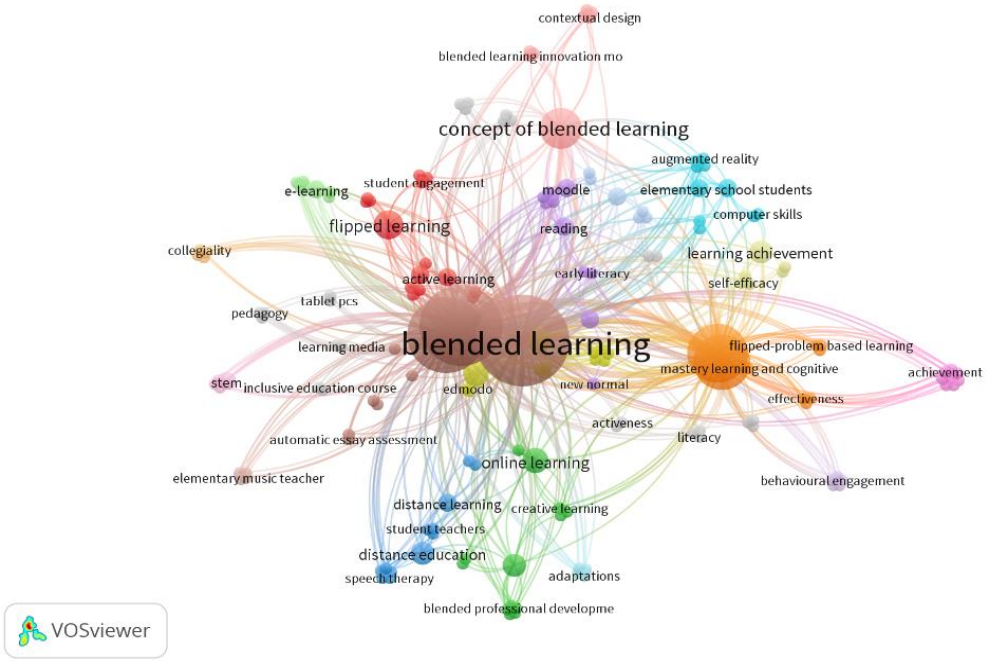

Figure 1. Initial network visualization

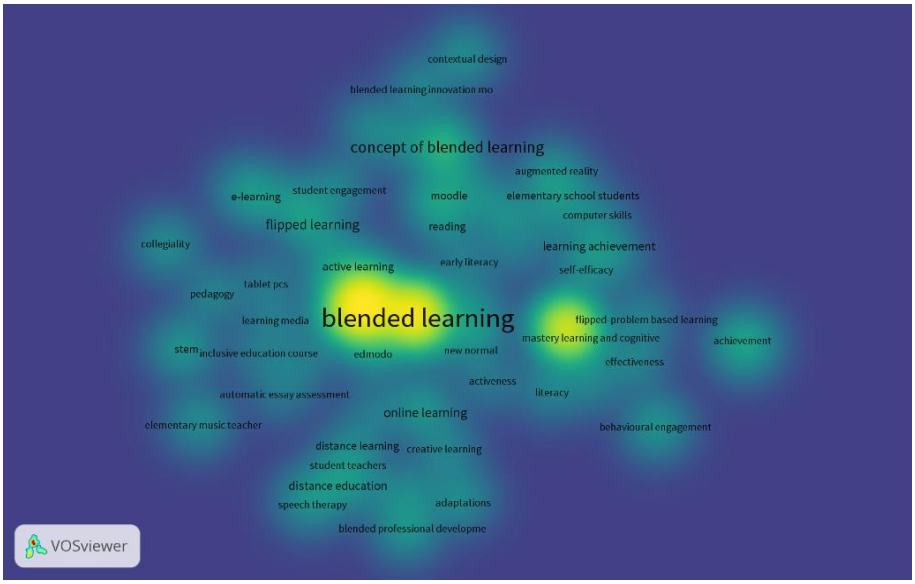

Figure 2. Visualizes article distribution based on keywords

2.4. PRISMA flow diagram

This study applied the PRIMA technique in searching articles through four stages. The stages are identification, screening, eligibility, and inclusion. The search stages with the PRISMA flowchart are described in Figure 3. The quantity of 906 articles were found on the Scopus database through Publish or Perish 7. Reports were then checked for similarities based on keywords, and 261 articles remained, while 645 similar articles were discarded. The article search was only on the Scopus database, so the resemblance was seen in the keywords used. Of the 261 articles, 175 irrelevant reports were discarded, the remaining 86 articles, then 60 full-text articles were selected, and the remaining 54 pieces were chosen according to the research question in terms of title, abstract, keywords, and comprehensive article substance. Next, the article was entered into Mendeley and saved in RIS format, then entered into the NVIVO 12 Plus application to be analyzed and reviewed. The results were presented according to the three research questions.

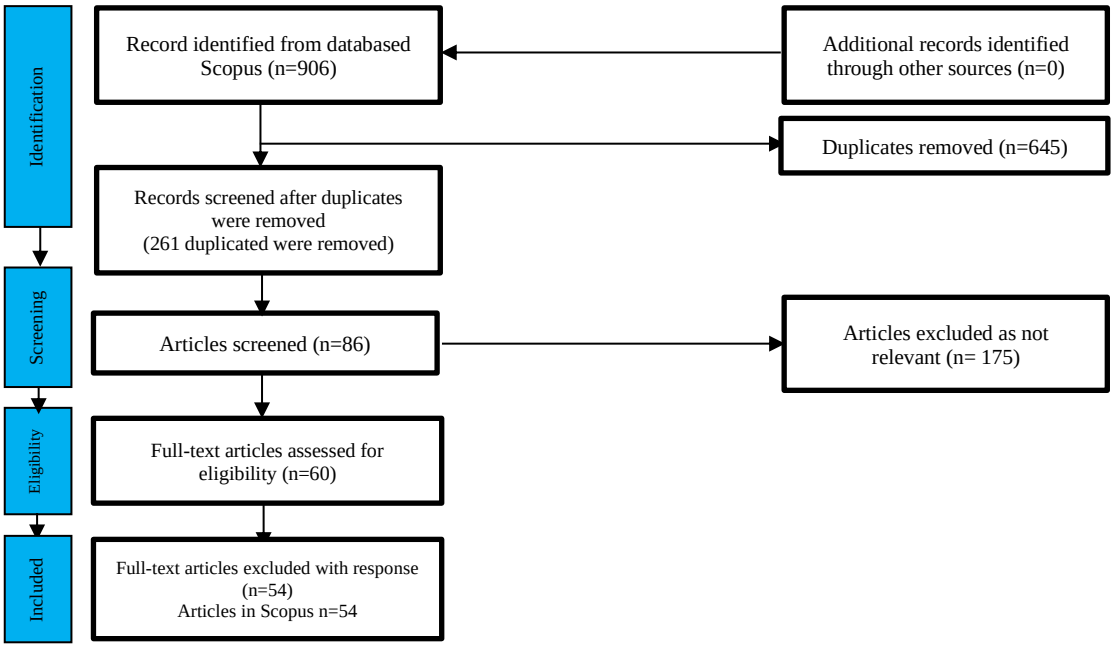

Figure 3. PRISMA flow diagram for systematic review [15], [66]

3. RESULTS AND DISCUSSION

After the results are obtained from the NVIVO 12 Plus application, it is necessary to present the findings of 54 articles according to researches, methodology, country, and relevance to research questions (RQ) 3.1 about concepts, 3.2 about types, and 3.3 about the impact of blended learning in science learning elementary school as displayed in Table 2. In the journal's column, explain the findings of the journal name, volume, edition, and year of publication. The methodology column describes the method/model/type of research used in the article. The country column describes the country where the research was conducted. The RQ column describes the article's relevance to the research question posed in this research.

3.1. The concept of blended learning in elementary school science learning

Blended learning is a learning model that integrates instructional modalities and methods (delivery media), combining face-to-face and virtual instruction. In blended learning, the number of face-to-face meetings is reduced and online learning is increased due to digital devices [67], [68]. Blended learning in primary school is an approach [69]. Most of them mentioned learning models with multiple modes of delivery [70], combining elements of teaching, learning, students, technology, course, online, curriculum [71], [72], and integrating synchronous and asynchronous digital technologies [73], [74], ICT with instruction from creative teachers to improve the quality of basic education [75]–[77]. Blended learning in elementary school science learning is a mixture of face-to-face and online learning to teach children about technology-assisted science that is cost-effective and requires teachers' digital skills as an alternative in the new normal and 21st century [78]–[81].

Blended learning in science requires a team of educators who bridge students to learn real content, blend with classroom materials and instructions, are student-centered, assess student learning progress, and integrate what students know with peers [82]. Blended learning is implemented in elementary schools by integrating face-to-face and online systems through YouTube [83], technological pedagogical content knowledge (TPACK), innovative multimedia [84], [85], Moodle, Blackboard, Edmodo, Android [86], and advanced professional technology [87]–[89]. Evaluating blended learning in elementary school is done through Automatic Essay Assessment [90].

3.2. The type of blended learning in elementary school science learning

The USA study examined the station rotation blended learning model, which positively impacted technology-based learning activities, student enjoyment, and ease of learning [91]. The USA flipped classroom study builds learning experiences and improves student learning outcomes [92]; Australia found the flipped classroom positively impacted student performance, satisfaction, and engagement in learning [93]. The flipped classroom is a type of blended learning that integrates conventional education with ICT (video clips, PowerPoint Prezi, digital pen, smart notebook, webcam recording, and keynote) [94], applied in basic science learning in elementary school [95], requires the synergy of teachers and students [96], makes students learn independently, achieve learning satisfaction [97], student experience and facilitate the evaluation of student learning outcomes [98].

The implementation of the flipped classroom in Indonesia is integrated with problem-based through a learning management system (LMS), Google Classroom [99], flipped classroom with group investigation strategy to increase the fun in science and math learning [100] Flipped classroom makes students active, creative, build knowledge and develop skills through technological innovation [101]. The mastery-based blended learning model is applied for students' cognitive achievement [102], project-based blended learning to support students' independent learning and development [103], and YouTube-based virtual remote and enriched type in elementary school to improve students' movement skills [104].

3.3. The impact of blended learning on elementary school science learning

The implementation of blended learning positively impacts student's performance and learning ability, satisfying individual differences, increasing students' interest, self-management, and good evaluation of learning compared to traditional and fully online learning [105], increasing digital literacy in students in the aspects of information management, communication, collaboration, sharing, creation, evaluation, problem-solving [106], students' self-learning and self-regulation skills [107], character, evaluating the effectiveness of blended learning at home and school [108], and early literacy in science and math materials through free websites [109]. The blended learning model is more effective in improving the understanding of STEM materials [110], abilities in STEM (creative and problem solving) of elementary school students' critical thinking skills [111], and science learning outcomes of plant tissue culture materials than traditional learning with a significance level of 0.05 on science process skills scores [112], improved student attitudes and academic achievement [113], elementary school students' activeness and creativity [114], student teachers' 21st-century skills [115], ease of teaching chemistry, geography, computational science,

and mathematics [116], improved learning outcomes in Physics, Biology, Chemistry, STEM [117], [118], motivations, engagement, and good completion of schoolwork [119].

Table 2. Findings of 54 selected articles from Scopus databases

No	Study	Methodology	Country	RQ
1	[67]	Conceptual research	Sweden	3.1
2	[68]	Interventional, nonrandomized and comparative	Brazil	3.1
3	[69]	Qualitative	Indonesia	3.1
4	[70]	Quantitative	Malaysia	3.1
5	[71]	Descriptive-qualitative	Indonesia	3.1
6	[72]	Analysis and exploration	Finland	3.1
7	[73]	Mixed-method	Hong Kong	3.1
8	[74]	Quasi-experiment	Indonesia	3.1
9	[75]	Quasi-experimental	Asian, American Indian	3.1
10	[76]	Survey	Japan	3.1
11	[77]	Case study	South Korea	3.1
12	[78]	Experimental	Taiwan	3.1
13	[79]	Systematic meta-aggregative review	Several countries	3.1
14	[80]	Qualitative and quantitative	Taiwan	3.1
15	[81]	Experimental	Indonesia	3.1
16	[82]	Qualitative inquiry	USA	3.1
17	[83]	Qualitative and quantitative	Indonesia	3.1
18	[84]	Quasi-experimental	Indonesia	3.1
19	[85]	Research and development	Indonesia	3.1
20	[86]	Qualitative	Indonesia	3.1
21	[87]	Experimental	Indonesia	3.1
22	[88]	Descriptive-qualitative	African, American, Asian	3.1
23	[89]	Quasi-experimental	Indonesia	3.1
24	[90]	Experimental	Indonesia	3.1
25	[91]	Focus group interviews	USA	3.2
26	[92]	Meta-analysis	USA	3.2
27	[93]	Questionnaire	Australia	3.2
28	[94]	Case study	Latvia	3.2
29	[95]	Mixed-design	South Africa	3.2
30	[96]	Systematic literature review	Several countries	3.2
31	[97]	Interview	South Korea	3.2
32	[98]	Mixed-method	Indonesia	3.2
33	[99]	Quasi-experimental	Indonesia	3.2
34	[100]	Literature review	Indonesia	3.2
35	[101]	Bibliometric analysis	Several countries	3.2
36	[102]	Quasi-experimental	Indonesia	3.2
37	[103]	Research synthesis	USA	3.2
38	[104]	Classroom action research	Indonesia	3.2
39	[105]	Descriptive analysis	China	3.3
40	[106]	Mixed-method	Taiwan	3.3
41	[107]	Explanatory sequential mixed method	Turkey	3.3
42	[108]	Questionnaire	Japan	3.3
43	[109]	Quasi-experimental	USA	3.3
44	[110]	Quantitative	Russian	3.3
45	[111]	Mixed-method	Nigeria	3.3
46	[112]	Quasi-experimental	Indonesia	3.3
47	[113]	Quasi-experimental	Turkey	3.3
48	[114]	Quasi-experimental	Indonesia	3.3
49	[115]	Quantitative	Turkey	3.3
50	[116]	Mixed-method	Canadian	3.3
51	[117]	Literature review	Indonesia	3.3
52	[118]	Survey	Indonesia	3.3
53	[119]	Research and development	Indonesia	3.3
54	[120]	Quantitative	USA	3.3

4. CONCLUSION

Blended learning in elementary school science learning is a mixed learning model (face-to-face and online) with synchronous-asynchronous technology integration, ICT, TPACK, multimedia, and Android, from planning to evaluation. The most studied type of blended learning is flipped classrooms (11 studies). While other types are only one study in the findings article, namely station rotation type, project-based type, remote, and enriched virtual type. The application of blended learning dominantly positively impacts students, namely helped performance, learning ability, satisfaction and self-regulation, increased interest, evaluation, digital literacy, initial literacy of science materials, understanding of STEM materials, physics,

chemistry, biology, and increased science process skills scores. The impact on teachers is that teaching chemistry, geography, science computing, and mathematics is easier. Future research needs to explore more about blended learning in elementary school science learning and what students, teachers, and technological developments need.

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